SP 212 FINAL

EXAM

8 MAY 2000

BLUE

NAME_____

ALPHA_____

PREFIXES

10^{9}	giga	G	10^{-3}	milli	m
10^{6}	mega	M	10^{-6}	micro	μ
10^{3}	kilo	k	10^{-9}	nano	n
10^{-2}	centi	c	10^{-12}	pico	p

DIRECTIONS:

1. Using a #2 pencil, fill out the information boxes on the front of the scan sheet as instructed by your instructor. On this sheet should be your alpha code, section number, name, and your instructor's name.

2. There are two versions of the exam, a GREEN version and a BLUE version. Please ensure you mark question 44 as **B** since you have a BLUE exam.

3. It is recommended that you postpone transferring your answers to the scan sheet until you have completed the exam. That way you are less likely to make erasures on the scan sheet.

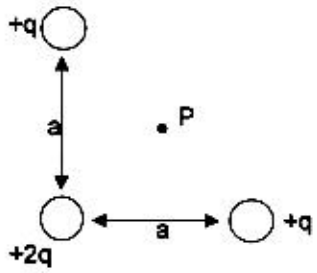
4. There are 43 multiple-choice questions. Please choose the response that best completes the question. You may use a formula sheet (provided by your instructor) and a calculator to assist you.

5. Before leaving you must turn in your exam booklet with your name and alpha code on it, your formula sheet, and any scratch paper used. Place the formula sheet and scratch paper inside the exam booklet.

1. Light with a wavelength of 550 nm is incident on a double-slit. The fourth bright fringe has an angular distance of 7.0° from the central maximum. What is the distance between the slits?

A. 27 μm
B. 21 μm
C. 24 μm
D. 18 μm
E. 14 μm

2. Two charges of $+q$, and one charge of $+ 2q$ are located at three corners of a square as shown. The electric field at point P in terms of q and a is



A. $4q/\pi\varepsilon_o a^2$ 

B. $2q/\pi\varepsilon_o a^2$ 

C. $3q/\pi\varepsilon_o a^2$ 

D. $q/\pi\varepsilon_o a^2$ 

E. $q/\pi\varepsilon_o a^2$ 

3. At what distance in km could one theoretically distinguish two automobile headlights separated by 1.5 meters? Assume a pupil diameter of 0.5 cm and yellow headlights seen at wavelength 500 nm. Assume eye fluid has an average n = 1.33.

A. 6 km
B. 12 km
C. 9 km
D. 3 km
E. 16 km

4. The drum of a photocopying machine is a cylindrical conductor with a length of 42 cm and a diameter of 12 cm. The magnitude of the electric field at the surface of the drum is $E = 2.3 \times 10^5$ N/C. The surface charge density of the drum is:

A. 3.57 $\mu C/m^2$
B. 0.64 $\mu C/m^2$
C. 1.29 $\mu C/m^2$
D. 2.03 $\mu C/m^2$
E. None of the above

5. A 30-turn solenoid is 12.0 cm long. The solenoid has a resistance of 13.5 mΩ and is connected to a 20.0 V battery. The magnitude of the magnetic field at the center of the solenoid is

A. 400 mT
B. 465 mT
C. 556 mT
D. 89.0 mT
E. 167 mT

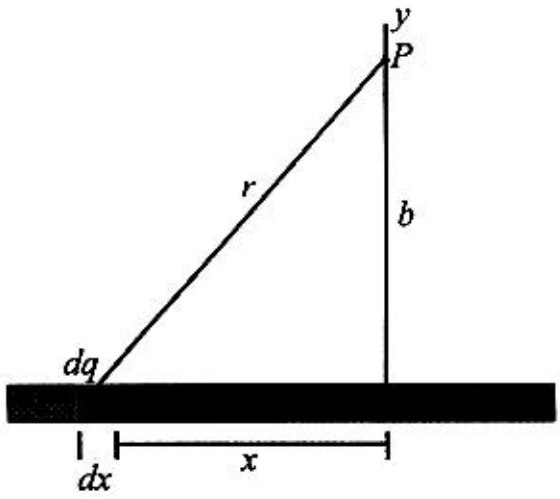
6. When a positive charge moves in the direction of an electric field,

A. the charge increases.
B. the field does work on the charge.
C. the charge decreases.
D. the charge gains potential energy.
E. the charge loses kinetic energy.

7. An electron is fired directly toward the center of a large non-conducting plate that has an excess surface charge density of -2.0 $\mu C/m^2$. The initial energy of the electron is 1000 eV. If the electron is to stop just prior to reaching the plate, it must be fired from a distance of:

A. 2.25 mm
B. 4.43 mm
C. 6.63 mm
D. 8.85 mm
E. 22.1 mm

8. A very long straight thin rod, a portion of which is shown, is uniformly charged with a charge per unit length of λ. The electric potential at point P a distance b from the rod can be calculated by evaluating the integral



A. $k_e \int_{-\infty}^{\infty} \frac{\lambda\, b x dx}{\left(x^2 + b^2\right)^{3/2}}$

B. $k_e \int_{-\infty}^{\infty} \frac{\lambda\, dx}{\left(x^2 + b^2\right)^{1/2}}$

C. $k_e \int_{-\infty}^{\infty} \frac{\lambda\, b dx}{\left(x^2 + b^2\right)^{3/2}}$

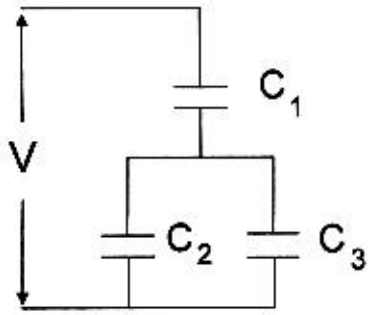
D. $k_e \int_{-\infty}^{\infty} \frac{\lambda\, dx}{x^2 + b^2}$

E. $k_e \int_{-\infty}^{\infty} \frac{\lambda\, x dx}{\left(x^2 + b^2\right)^{1/2}}$

9. If the potential difference across a capacitor is doubled, the energy stored in the capacitor is

A. doubled.
B. increased four times.
C. halved.
D. remains the same.
E. decreased four times.

10. In the figure to the right ideal capacitors $C_1 = 3.00\ \mu F$, $C_2 = 4.00\ \mu F$, and $C_3 = 2.00\ \mu F$. A potential difference of V = 120 V is placed across the circuit. The charge on capacitor C_1 is



A. 108 μC
B. 130 μC
C. 180 μC
D. 240 μC
E. 520 μC

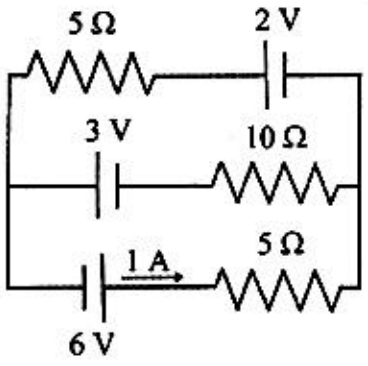
11. An electron moves perpendicular to a uniform magnetic field at 1.00×10^7 m/s and experiences an acceleration of 2.00×10^{16} m/s^2 in the negative *x* direction when its velocity is in the negative *z* direction. The magnitude and direction of the magnetic field is

A. 2.25 mT, $-y$
B. 11.4 mT, $+y$
C. 22.0 mT, $+z$
D. 65.9 mT, $-x$
E. 89.0 mT, +y

12. The potential across a conductor is doubled. By what factor will the drift velocity of the charge carriers in the conductor be affected?

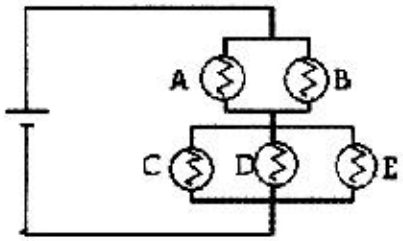
A. 1
B. 2
C. ½
D. 4
E. ¼

13. In the circuit to the right all batteries are ideal. The current through the 10 Ω resistor is



A. 0.2 A
B. 0.4 A
C. 0.6 A
D. 0.8 A
E. 1.0 A

14. In the circuit shown the light bulbs are identical and the battery is ideal. Bulb D is removed.

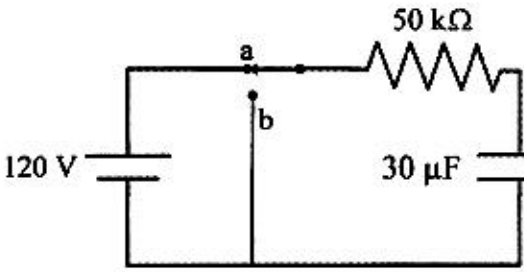


A. Bulb A gets brighter.
B. Bulb A gets dimmer.
C. Bulb A remains the same.
D. Bulb A goes out.
E. Need more information.

15. A charge of −15 C is placed on a spherical conducting shell. In addition, a + 6 C point charge is placed at the center of the shell's cavity. The net charge on the outer surface of the shell is:

A. −21 C
B. −15 C
C. +9 C
D. −6 C
E. −9 C

Questions 16 and 17 refer to the RC circuit to the right. In this circuit the battery and the capacitor are ideal.



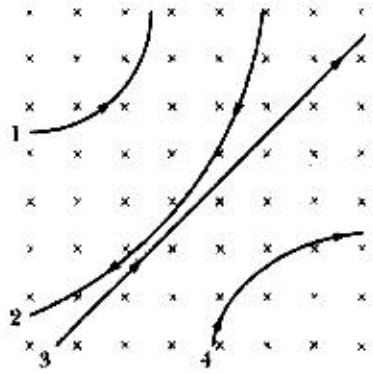
16. The time constant for this circuit is

A. 0.5 s
B. 1.0 s
C. 1.5 s
D. 2.0 s
E. 3.0 s

17. After a long time, the switch is moved from position **a** to position **b**. 3.0 s later, the energy stored in the capacitor is

A. 4 mJ
B. 8 mJ
C. 11 mJ
D. 29 mJ
E. 80 mJ

18. In the figure to the right, a uniform magnetic field is directed into the page. The paths of four particles are shown as they move through the region. Pick the column below that best describes the charge on each particle.

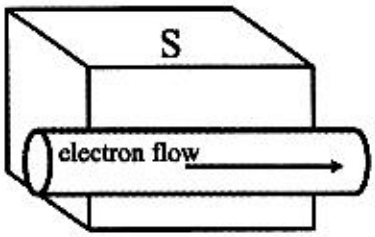


	A.	B.	C.	D.	E.
1	positive	negative	positive	negative	negative
2	negative	positive	positive	negative	neutral
3	neutral	neutral	negative	neutral	positive
4	negative	positive	neutral	positive	positive

19. Two conductors are made of the same material and have the same length. They each have circular cross sectional areas. Conductor A's radius is twice conductor B's radius. They have the same electrical potential across their lengths. The current through conductor A will be

A. twice the current through conductor B.
B. four times the current through conductor B.
C. the same as the current through conductor B.
D. half the current through conductor B.
E. one-quarter the current through conductor B.

20. The figure shows the motion of electrons in a wire that is near the *S* pole of a magnet. The wire will experience a force



A. toward the magnet
B. away from the magnet
C. downwards
D. along its length
E. upwards

21. A rectangular loop is placed in a uniform magnetic field with the plane of the loop parallel to the direction of the field as shown. If a current is made to flow in the loop in the direction shown, the loop will experience

A. a net force.
B. a net torque.
C. a net force and a net torque.
D. neither a net force nor a torque..
E. need more information.

22. A possible means of space flight is to place a perfectly reflecting aluminumized sheet into earth orbit and use the light of the sun to push this solar sail. If a huge sail of area 6.00×10^5 m^2 were placed into orbit around the earth and turned toward the sun, what would be the force on exerted on the sail? (assume a solar intensity of 1380 W/m^2 near the earth).

A. 1.76 N
B. 2.76 N
C. 5.52 N
D. 11.0 N
E. 65. 0 N

23. A battery attached to a load supplies 2 A with a terminal voltage of 12.0 V. If the battery's internal resistance dissipates 0.4 W, its emf is

A. 11.8 V
B. 12.0 V
C. 12.2 V
D. 12.4 V
E. 12.6 V

24. In the figure to the right, a closed loop moves at a constant speed parallel to a long straight current carrying wire. As the loop moves

A. an induced current will progress clockwise.
B. there will be no induced current in the loop.
C. an induced current will progress counterclockwise.
D. the induced current will vary with the speed at which the loop moves.
E. None of these.

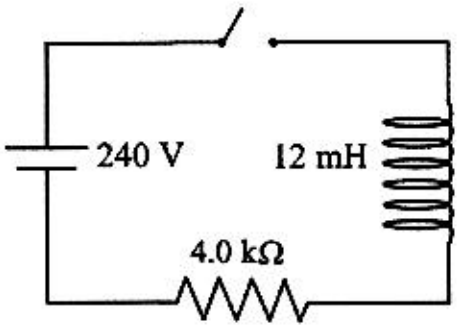
25. A circular loop with a radius of 20.0 cm sits in a uniform magnetic field. The magnetic field is perpendicular to the plane of the coil and varies at a rate of 150 mT/s. The magnitude of the emf induced in the coil is

A. 158 mV
B. 94.2 mV
C. 75.3 mV
D. 18.8 mV
E. 5.02 mV

26. The number of turns of a solenoid is doubled resulting in a doubling in the length of the solenoid. The self-inductance of the solenoid

A. remains the same.
B. is doubled
C. is tripled
D. is quadrupled
E. is halved.

27. In the circuit to the right, the battery and the inductor are ideal. At $t = 0$, the current in the circuit is zero and the switch is shut. When the current in the circuit is 15 mA, the potential difference across the inductor is

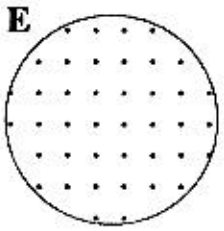


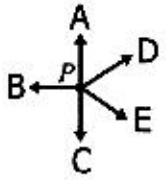
A. 240 V
B. 60 V
C. 0 V
D. 180 V
E. 190 V

28. The magnetic field inside a superconducting solenoid is 4.50 T. The solenoid has an inner diameter of 6.20 cm and a length of 26.0 cm. The magnetic energy density of the field is

A. 8.06 MJ/m^3
B. 1.43 kJ/m^3
C. 3.18 $\mu J/m^3$
D. 1.62 kJ/m^3
E. 4.03 MJ/m^3

29. The figure to the right shows a region of electrical field confined to a circular area. The field is decreasing at a rate of 15 V/m-s. Pick the arrow corresponding to the direction of the induced magnetic field at point P.





30. The frequency of oscillation of a certain LC circuit is 200 Hz. The circuit consists of a 6.33 nF capacitor and an inductor with an inductance of

A. 1.00 H
B. 5.00 H
C. 10.0 H
D. 50.0 H
E. 100 H

31. A long straight wire has a diameter of 4.0 mm carries a current of 40 A. The magnitude of the magnetic field 1.5 mm from the center of the wire is

A. 3.0 mT
B. 13 mT
C. 5.3 mT
D. 8.4 mT
E. 7.0 mT

32. Unpolarized light is passed through three successive Polaroid filters, each with its transmission axis at 45° to the preceding filter. The percentage of the original light intensity exiting the last filter is

A. 0
B. 12.5
C. 25
D. 50
E. 33

33. When light moves from a medium where its speed is higher to a different medium where its speed is slower, the refracted ray is bent

A. away from the normal.
B. along the normal.
C. along the surface.
D. perpendicular to the normal.
E. toward the normal.

34. A layer of kerosene (n = 1.45) is floating on water (n = 1.33). For what angles of incidence at the kerosene-water interface will light be totally internally reflected within the kerosene?

A. $\theta < 32.1^\circ$
B. $\theta > 66.5^\circ$
C. $\theta < 42.1^\circ$
D. $\theta > 55.1^\circ$
E. $\theta > 45.2^\circ$

35. A light ray whose frequency is 6×10^{14} Hz in a vacuum is incident on water (n = 1.33). The wavelength of the light after it enters the water is

A. 798 nm
B. 500 nm
C. 376 nm
D. 665 nm
E. 266 nm

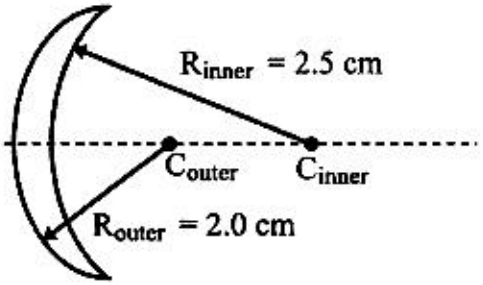
36. Two mirrors are at right angles to one another. A light ray is incident on the first at an angle of 30° with respect to the normal to the surface. What is the angle of reflection from the second surface?

A. 30°
B. 53°
C. 45°
D. 75°
E. 60°

37. A mid stands 5 m in front of a convex mirror with a radius of curvature of 100 cm. How tall will she appear in the mirror if she is 2 m tall?

A. 68 cm
B. 48 cm
C. 18 cm
D. 88 cm
E. 22 cm

38. The contact lens to the right is made of plastic with an index of refraction of 1.50. The lens has an outer radius of curvature of +2.0 cm and an inner radius of curvature of +2.5 cm. This lens will tend to



A. bend rays toward the principle axis.
B. allow rays to pass through unchanged.
C. bend rays away from the principle axis.
D. refract rays away from the principle axis.
E. None of the above

39. An object is placed 6 cm in front of a lens that has a focal length of 4 cm. What is the character of the image?

A. real and inverted
B. real and upright
C. real and horizontal
D. virtual and upright
E. virtual and inverted

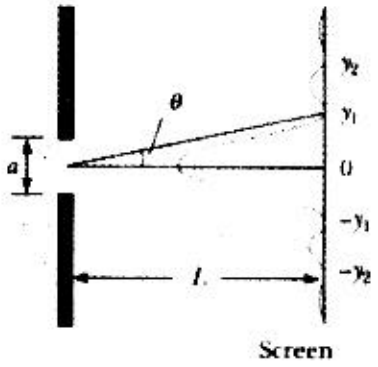
40. A thin sheet of plastic (n = 1.6) is inserted between two panes of glass (n =1.33) to reduce infrared (λ = 760 nm) losses. What is the minimum thickness necessary to produce constructive interference in the reflected infrared radiation?

A. 238 nm
B. 119 nm
C. 55 nm
D. 318 nm
E. 443 nm

41. A charge of $+q$ is placed at the origin of a coordinate system, and a charge of $+Q$ is located at $+a$ on the x-axis. The force on $+Q$ is found to be F. A third charge $-q$ is placed at $+2a$ on the x-axis. The force on $+Q$ is now

A. zero
B. F
C. 0.5 F
D. 1.25 F
E. 2 F

42. A single slit of width 1.00 mm is illuminated with light of 600 μm. What angle θ, shown in the figure, is associated with the first dark fringe?



A. 36.9°
B. 0.564°
C. 6.87°
D. 42.4°
E. 0.600°

43. The amount of charge inside a sphere is doubled. The net electric flux through the sphere is

A. doubled.
B. halved.
C. increased by a factor of three.
D. increased by a factor of four.
E. remains the same

44. If your test is printed on GREEN paper mark response A. If it is printed on BLUE paper mark response B.

A. GREEN
B. BLUE
C.
D.
E.